CLAIMS

[1] A communication control system for controlling communications performed between a plurality of communication stations that are connected to communication paths being multiplexed with a main path and a sub-path, the communication control system comprising:

communication function implementing sections for implementing a communication function, which are multiplexed so as to correspond with the main path and the sub-path respectively;

a high-priority communication section for performing a high-priority communication via the communication function implementing section corresponding to any one of the multiplexed communication paths; and

a low-priority communication section for performing a low-priority communication via the communication function implementing section corresponding to the sub-path,

wherein the high-priority communication section and the low-priority communication section coexist in a single communication station.

[2] A communication control system for controlling communications performed between a plurality of communication stations that are connected to communication paths being multiplexed with a main path and a sub-path, the communication

control system comprising:

first communication function implementing sections which are multiplexed so as to correspond with the main path and the sub-path respectively, and each of which implements a communication function in a physical layer of an OSI hierarchical model;

second communication function implementing sections which are multiplexed so as to correspond with the multiplexed first communication function implementing sections respectively, and each of which implements a communication function in a data link layer of the OSI hierarchical model;

a high-priority communication section for performing a high-priority communication via the communication function implementing section corresponding to any one of the multiplexed communication paths; and

a low-priority communication section for performing a low-priority communication via the communication function implementing section corresponding to the sub-path,

wherein the high-priority communication section and the low-priority communication section coexist in a single communication station.

[3] The communication control system according to claim 2, wherein the second communication function implementing section includes:

an address storing section for storing MAC addresses corresponding to the high-priority communication section and the low-priority communication section respectively;

a transmitting section which attaches the corresponding MAC address to a communication frame depending on whether a transmission requestor is the high-priority communication section or the low-priority communication section, and transmits the communication frame to the communication path; and

a receiving section which compares a destination MAC address of a communication frame received from the first communication function implementing section with the MAC address stored in the address storing section, and when a match is found in the comparison result, sends the received communication frame to the corresponding communication section.

[4] The communication control system according to claim 2 or 3, further comprising:

a multicast address storing section for storing a plurality of MAC multicast addresses,

wherein when a destination MAC address of a communication frame received from the communication path matches with any one of the addresses stored in the MAC multicast address storing section, the second communication function implementing

section sends the communication frame to the high-priority communication section, and

otherwise the second communication function implementing section sends the communication frame to the low-priority communication section.

[5] The communication control system according to claim 1, wherein units each including the high-priority communication section, the low-priority communication section and the communication function implementing sections, or units each including the high-priority communication section, the low-priority communication section, the first communication function implementing sections and the second communication function implementing sections are provided and multiplexed in a single communication station, and

one unit serves as an active unit and the other unit serves as a standby unit.

[6] A communication control system for controlling communications performed between a plurality of communication stations that are connected to communication paths being multiplexed with a main path and a sub-path, the communication control system comprising:

a high-priority communication section for performing a high-priority communication normally via the main path;

a low-priority communication section for performing a low-priority communication via the sub-path;

a path diagnosing section for diagnosing a soundness of the main path and the sub-path; and

a switching section for switching the communication path of the high-priority communication to the sub-path when the main path is diagnosed as faulty as a result of diagnosis by the path diagnosing section.

[7] The communication control system according to claim 6, wherein the path diagnosing section includes:

a path state storing section for storing path state information of a path state from a home station to each communication station; and

a fixed-cycle path diagnosing section for diagnosing the communication path from the home station to each communication station in a fixed cycle,

wherein the fixed-cycle path diagnosing section registers the path state information obtained from the diagnosis result, in the path state storing section.

[8] The communication control system according to claim 7, wherein the fixed-cycle path diagnosing section includes a diagnosis packet transmitting section for broadcasting to other communication stations a path diagnosis packet including

receive state information of path diagnosis packets from other communication stations, and

on receiving a path diagnosis packet, the fixed-cycle path diagnosing section registers in the path state storing section receive state information of the path diagnosis packet transmitted by the home station, the receive state information being included in the received path diagnosis packet, as the path state information of the communication path from the home station to a transmitting source of the path diagnosis packet.

[9] The communication control system according to claim 7 or 8, wherein the fixed-cycle path diagnosing section broadcasts a path diagnosis packet in accordance with a multicast protocol of Internet Protocol,

different IP multicast addresses are assigned to the main path and the sub-path respectively, and

each communication station performs broadcasting by using the IP multicast address corresponding to a path selected between the main path and the sub-path, as a destination IP address, and receives a path diagnosis packet of which destination IP address matches with the IP multicast address corresponding to each of the main path and the sub-path.

[10] The communication control system according to claim 6, further comprising:

a data transmitting section which transmits data to another communication station, and retransmits the data when a normal reception response is not returned from the another station within a predetermined time; and

a data receiving section for returning a normal reception response to a transmitting source when data is normally received.

[11] The communication control system according to claim 10, further comprising:

a path state storing section for storing path state information of a path state from a home station to each communication station;

a counting section for counting times of the data transmitting section retransmitting the data; and

a registering section which, when a count value of the counting section reaches a specified value, determines the communication path as faulty and registers the path state information indicating that the path is faulty, in the path state storing section.

[12] The communication control system according to claim 10, further comprising:

a counting section for counting times of the data transmitting section retransmitting the data; and

a switching section which, when a count value of the counting section reaches a specified value, determines the communication path as faulty and switches the communication path.

[13] The communication control system according to claim 6, further comprising:

a multiplexed communication station where units each including the high-priority communication section, the low-priority communication section, the path diagnosing section and the switching section are provided while being multiplexed, any one of the units serves as an active unit and the other unit serves as a standby unit, and a different address is assigned to the high-priority communication section of each unit,

wherein another communication station which performs a transmission to the multiplexed communication station performs communication by designating the active unit, and when failing to communicate with the active unit via any one of the multiplexed communication paths, retries to communicate by switching a designation to the standby unit.

[14] The communication control system according to claim 13, wherein the multiplexed communication station each includes a self diagnosing section,

the self diagnosing section in the active unit halts a communication operation while placing the home unit in a standby state on detecting a failure,

the standby unit places the home unit in the active state so as to start a communication operation when the other unit halts the communication operation, and broadcasts to the other communication stations that the home unit has become the active unit, and

each communication station includes a table storing information indicating which unit of the multiplexed communication station is active, performs transmission to the active unit while referencing the information stored in the table, and updates the information in the table when receiving the broadcast communication.

[15] The communication control system according to claim 6, wherein while the path diagnosing section detects a failure in the main path, the path diagnosing section broadcasts the failure in the main path to all communication stations in a fixed cycle.

[16] The communication control system according to claim 15, wherein when the low-priority communication section receives a broadcast notice indicating that the main path is faulty, the low-priority communication section controls a

transmission so that a transmission count per unit time of low-priority communication is equal to or smaller than a predetermined value,

and when the broadcast notice is not received for equal to or more than a predetermined time, the low-priority communication section determines that the main path is restored to normal operation and halts the transmission control of making the transmission count be equal to or smaller than the predetermined value.

[17] The communication control system according to claim 6, wherein while the low-priority communication section recognizes the main path as faulty, the low-priority communication section controls a transmission so that a transmission count per unit time of the low-priority communication is equal to or smaller than a predetermined value.

[18] The communication control system according to claim 6, wherein in a case where the low-priority communication section is recognizing the main path as faulty, while the sub-path is not under transmission, the low-priority communication section immediately performs the high-priority communication, and while the sub-path is not under transmission and there is no high-priority communication waiting to be transmitted, the

low-priority communication section performs the low-priority communication.

[19] The communication control system according to claim 6, further comprising:

an authentication section which performs authentication between the high-priority communication sections in different communication stations so as to enable communication between the authenticated communication stations.

[20] The communication control system according to claim 19, wherein the authentication section includes:

a public key generating section for generating an electronic public key to be exchanged between the home station and another communication stations from an electronic private key that is unique to the home station;

a key transmitting section for broadcasting the generated public key to all communication stations;

a common key generating section which generates an electronic common key that is unique to the home station and another communication station from a public key received from the another station and the private key of the home station, generates the electronic common key for each communication station, and stores the generated common key;

an authentication packet transmitting section which

performs at least either encryption of a packet or attachment of an authentication value to a packet by using the generated common key, and transmits at least either the encrypted packet or the packet to which the authentication value is attached; and

an authentication packet receiving section which performs at least either decoding of the received packet by using the common key or determination on whether reception is allowed based on the common key and the authentication value being attached to the packet.

[21] The communication control system according to claim 20, wherein the common key generating section generates the common key from the private key and the public key by using Differ-Hellman method.

[22] The communication control system according to claim 20, further comprising:

a key update section for updating the common key by changing the private key per predetermined time;

a confirming section which stores the common key just before update and a latest common key, confirms the authentication value by using the latest common key on receiving the packet, and in a case where the confirmation is determined as illegal, confirms the authentication value by

using the common key just before update; and

a decoding section for performing decoding of the packet by using either the common key just before update or the latest common key by which the authentication value is confirmed as valid.

[23] The communication control system according to claim 1, 2 or 6, wherein a router for performing a path control of the communication path in accordance with Internet Protocol is provided on the communication path, and the communication path includes a plurality of sub-networks being interconnected by the router.

[24] The communication control system according to claim 23, wherein a sole master station exists on the sub-network,

the master station transmits an inter-network diagnosing frame including path state information on the paths between the home station and all another communication stations existing on the sub-network to which the home station belongs and path state information on the path between the home station and a master station existing on a sub-network to which the home station does not belong, and

each of all communication stations on the plurality of sub-networks including the master station and the other communication stations includes:

a path state storing section for storing path state information indicating whether the communication path from the home station to each of another communication stations is sound;

a diagnosing message receiving section which registers in the path state storing section the path state between the home station and the communication station existing on the sub-network to which the home station does not belong, based on the path state information included in the inter-network diagnosing frame; and

a data transmitting section which selects either the main path or the sub-path in accordance with the information in the path state storing section, and performs transmission of data.

[25] The communication control system according to claim 24, further comprising:

a selecting section which generates a list of network addresses of all communication stations existing on the sub-network, and in a case where an address of the home station is the address that is uniquely determined among the list based on a predetermined condition, causes the home station to operate as the master station on the sub-network.

[26] The communication control system according to claim 1, 2 or 6, wherein the high-priority communication section

performs communication in accordance with a protocol dedicated to process control, and

the low-priority communication section performs communication in accordance with an open standard protocol.

[27] The communication control system according to claim 1, 2 or 6, wherein the high-priority communication section transfers at least one of process data, an operation amount and an alarm, and

the low-priority communication section performs at least one of image data transfer, file transfer and message transfer.